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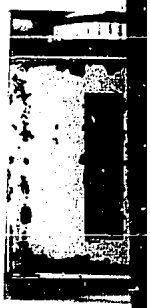

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NEW TYPES OF CURRENT TRANSFORMERS AT THE "URALELEKTROAPPARAT" PLANT

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The accelerated demand for instrument transformers has set the "Uralelektroapparat" Plant the task of creating new types of transformers, which are cheap, simple in design, and have increased ability to withstand short-circuit currents. A design meeting these conditions can usually be obtained by reducing primary turns to a minimum. However, this is possible only to a certain extent, since the accuracy of the transformer is lowered as the primary turns decrease.

On the other hand, the accuracy can be increased, either by increasing the area of cross section of the transformer core, or by using magnetic materials with high magnetic permeability. The first method increases the size and weight of the transformer and is therefore unsuitable. The second method provides the best solution to the problem. Up to the present, a material with a high magnetic permeability, known as "permalloy," was usually employed for this purpose. Use of permalloy enables one to produce accurate and small current transformers, but the relatively high cost of permalloy results in a considerable increase in the cost of the transformer.

The new Marks VP and KhVP transformer steels, designed by Soviet metallurgists, are being used for the first time in the new current transformers produced by the "Uralelektroapparat" Plant. The cost of these steels differs only slightly from that of ordinary transformer steel.

Mark VP steel has very high initial permeability. Due to the fact that the crystals of the metal are not orientated, it is possible to stamp and cut the metal along and across the line of rolling. This fact is responsible for its use in current transformers, which have cores made of stamped plates.

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KhVP transformer steel has a high initial magnetic permeability only along the line of rolling, which results in its being used only in current transformers with ring-shaped, spiral cores.

As is well known, during the cutting, stamping, and winding of the cores, the metal undergoes deformation above the elastic limit, which causes residual deformation of the crystal-lattice structure and also a partial crushing of the crystals. As a result, the magnetic properties of the steel deteriorate. In order to restore the magnetic characteristics of cores, they are subjected to repeated annealing. The B = f(H) curves for Mark VP and KhVP steels are fairly linear for portions illustrated: VP - 7,200 gausses at 0.7 ampere-turns/centimeter; KhVP - 11,200 gausses at 0.5 ampere-turns/centimeter (at upper limits).

The "Uralelektroapparat" Plant has designed and is producing the following new types of current transformers:

1. Type TKM transformers for voltages up to 500 volts; accuracy, classes 0.5 percent and one percent.

2. Type TKF transformers, for 3 kilovolts; accuracy, classes 0.5 percent and one percent.

3. Small-size laboratory transformers, Type TLM for a voltage of 500 volts; accuracy, class 0.2 percent.

4. Type TPF and TPFU transformers, for 6-10 kilovolts, and 5-400 amperes; accuracy, class 0.5 percent.

5. Single-turn transformers, types TPOF and TPOFU for 10 kilovolts and 400-1,500 amperes; accuracy, classes 0.5 percent and one percent.

6. Type TV-35-MKL transformers, installed in oil breakers.

TKM-Series Current Transformers for Currents from 10 to 600 Amperes and Voltages up to 500 Volts

Type TKM current transformers are manufactured in the following two modifications: TKM-1-0.5/10-600 (percent accuracy class/rated amperes), 0.6 ohm rated secondary load; and TKM-0.5-0.5/10-600, 0.4 rated secondary load. Both have the same weight (3.5 kilograms), dynamic stability factor (50-65), one-second thermal stability (50-65), and saturation factor (5-7).

The use of VP steel as a material for the core has made it possible to produce a Type TKM current transformer in the one-percent accuracy class with 600 primary ampere-turns and a secondary load of 0.6 ohm.

The production of transformers in the 0.5 accuracy class on the basis of the same parts and with the same number of primary ampere-turns is a more difficult task, due to the fact that the angular errors of this transformer exceed the permitted amounts. Therefore, it was necessary to resort to artificial compensation of the error by the magnetization method.

TKF-Series Current Transformers for Currents of 5-600 Amperes and Voltages up to 3 Kilovolts

The use of VP steel in Type TKF transformers (coal with porcelain insulation) increased their accuracy and ability to withstand short-circuit currents. The new series of TKF current transformers made from VP steel differs from the old series only as regards the material of the cores. The construction and clearances of the transformers are in complete accordance with catalog data of the old series.

The characteristics of the new series of Type TKF current transformers are as follows:

TKF-0.5-3/5-600 (percent accuracy/rated amperes)

0.8 ohm
Dynamic stability, 100
One-second thermal stability, 75
Saturation factor, 15

TKF-1-3/5-600

0.8 ohm
Dynamic stability, 200
Thermal stability, 80
Saturation factor, 7

In comparison with the old series, the new series of Type TKF current transformers has the following advantages:

1. The series is supplemented by transformers of the 0.5-percent accuracy class with the same dimensions and weight as the TKF transformers of the one-percent accuracy class of the old series.

2. The creation of a new TKF current transformer of the one-percent accuracy class, having smaller size and weight, and greater durability at short circuit currents, with a smaller saturation factor.

Type TLM-0.2 Laboratory Current Transformers

The plant has designed current transformers with very small dimensions 155 x 135 x 65 millimeters and a total weight of 3 kilograms) in the 0.2-percent accuracy class with KhVP steel cores. The transformers will be produced in two modifications: (1) for primary currents of 15-50-100-150-200,300-600 amperes and (2) for primary currents of 750-1,000-1,500 amperes.

Thus, a set of two current transformers will make it possible to measure currents of 15 to 1,500 amperes, with an accuracy of 0.2 percent and a secondary load of 0.2 and 0.4 ohms, respectively. These transformers are very simple to manufacture, and reliable in operation.

The use of cold-rolled transformer steel makes it possible to produce stable transformer characteristics, which cannot be said of transformers with permalloy cores. It is well known that permalloy is very sensitive to all kinds of mechanical shocks and shaking and its magnetic characteristics are thereby made worse.

TPF-and TPFU Series Current Transformers for Voltages of 6-10 Kilovolts and Currents of 5-400 Amperes in the 0.5-Percent Accuracy Class

Up to the present, the TPF multiturn bushing-type current transformers in the 0.5-percent accuracy class had an average of 900 ampere-turns. At the same time, "reinforced" current transformers, with increased thermal and dynamic stability, were also produced. This reinforcement was attained by reducing the number of nominal ampere-turns, which in turn required considerable improvement in the magnetic characteristics of the cores. For this purpose, a certain amount of permalloy was added to ordinary E4AA steel. This improved the magnetic characteristics of the core in weak fields.

The new Mark VP-2 and VP-3 steel has higher induction for the same magnetic field intensities. Design of the new TPF-0.5 series of transformers was based on this property of the new Mark VP steel.

As a result, the use of VP steel has enabled the number of primary ampere-turns in the new series of TPF transformers of the 0.5-percent class to be reduced from 900 to 600, while in the TPFU transformers of the same class of accuracy, it has been possible to discontinue the use of permalloy.

Reducing the nominal number of ampere-turns from 900 to 600 in the TPF transformers gives an increase in electrodynamic stability and also makes it possible to reduce the amount of copper in the primary winding.

Single-Turn-Current Transformers of TPOF and TPOFU Series for Voltages of 10 Kilovolts and Currents of 400-1,500 Amperes

As was stated above, the fact that the extremely high magnetic permeability of Mark KhVP steel is manifested only along the line of rolling limits its field of application to current transformers with ring-shaped, spiral cores. Among these are the single-turn bushing-type current transformers (Types TPOF and TPOFU). The old current transformers of this series for currents of 400, 600 and 750 amperes had cores which were larger and heavier, and had cumbersome artificial compensation for errors. Moreover, the selection of cores for the same currents for the 0.5-percent accuracy class presented very great difficulties.

The new TPOF-series transformers with KhVP steel cores do not have these disadvantages. The use of KhVP steel cores has enabled artificial error compensation to be done away with.

It has also been possible to considerably reduce the size and weight of the cores, and also to reduce the length of the insulators from 90-170 millimeters. At the same time, the following advantages have been achieved in the new Type TPOF series of current transformers: (1) increase of dynamic stability due to a reduction in length of the insulator, (2) reducing the saturation factor due to a decrease in cross section of the cores, and (3) considerable reduction in the weight of completed transformers, mainly due to the reduction in the weight of the cores.

Type TV-35-MKP Current Transformers Installed In Oil Breakers

Previously, the measurement of currents for voltages higher than 10 kilovolts at open substations was carried out by means of current transformers of Type TFN, which were complicated and expensive.

However, in many cases, when it is permissible to carry out the measurement with an error of 3 to 10 percent, it is possible to use current transformers installed in oil breakers. Measurement of power and power consumption using current transformers with this degree of accuracy is not possible.

The development of the new series of Type TV current transformers, built into oil breakers, was undertaken with the object of increasing the accuracy of this type of transformer, and making it possible to replace the extremely cumbersome and complex Type TFN transformers.

The basic operational advantages of built-in current transformers, as compared with Type TFN transformers, are obvious. The first series of such current transformers was made by the "Uralelektroapparat" Plant for MKP-35 breakers. It is not possible, as yet, to completely replace the TFN

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current transformers for breakers of this type rated at 150 to 1,000 amperes despite the fact that the new transformers are the most perfected and accurate of all the built-in current transformers existing at present. The dimensions of the new series of transformers allow 12 instead of six of them to be installed in the breaker. Moreover, at currents of 300 amperes and over, these transformers have a one-percent accuracy. Consequently, in such cases they can be used to replace the externally fitted transformers of the TFN series.

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